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APPLICATION FOR

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SPECIFICATION

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Title of the Invention: PICTURE DISTRIBUTION SYSTEM AND METHOD
THEREOF

PICTURE DISTRIBUTION SYSTEM AND METHOD THEREOF**Cross Reference**

5 The subject matter of this application is related to that disclosed in U.S. application 09/450,616. That U.S. application 09/450,616 is incorporated herein by reference.

Background of the Invention**10 Field of the Invention**

The present invention relates to a system for distributing picture data and in particular relates to a system for distributing a plurality of picture data from a picture distribution device to a plurality of picture receiving devices by a time division multiplex method using a ring-shaped transmission line.

Description of the Related Art

20 A system for displaying pictures taken by a plurality of cameras at a plurality of terminals is widely used in a variety of fields. For example, a system in which monitor cameras are installed at a plurality of locations, the picture from each monitor camera is transmitted to a central station via a

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Fig. 1 shows the configuration of an example of an existing picture distribution system. This system comprises a plurality of cameras 101a-101c, a distribution device 102 for transmitting picture data outputted from each of the cameras 101a-101c to a network, a plurality of receiving devices 103a-103c for receiving the picture data from the network and a plurality of picture monitors 104a-104c for displaying the picture data received by corresponding receiving device. In this case, the network is a ring-shaped transmission line 105. A plurality of

logical channels #a-#c are established in the transmission line 105.

Each of the receiving devices 103a-103c receives picture data from a respective predetermined logical channel. In the example shown in Fig. 1, the receiving devices 103a-103c receive picture data from the logical channels #a-#c, respectively.

The distribution device 102 transmits picture data outputted from each of the cameras 101a-101c to a corresponding logical channel. In the example shown in Fig. 1, a distribution request "to display picture data taken by a camera 101a on a picture monitor 104b and to display picture data taken by a camera 101b on picture monitors 104a and 104c" is issued to the distribution device 102. Therefore, the distribution device 102 transmits the picture data taken by the camera 101a to a logical channel #b and transmits the picture data taken by camera 101b to logical channels #a and #c. A distribution request is, for example, issued from the central station, which is not shown in Fig. 1.

According to the system described above, pictures taken by a plurality of specific cameras can be displayed on a plurality of respective supervisory monitors.

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In the system described above, the transmission method of picture data is not limited to the method described above. However, in a system for monitoring the traffic condition of a road, the situation of a river, etc., it is anticipated that a picture taken by each camera is displayed for a fairly long time. In this case, the amount of picture data transmitted from each camera to a supervisory monitor does not vary greatly as time elapses. Therefore, such a system often adopts time division multiplexing as a transmission method of picture data.

In a time division multiplex method, picture data are usually stored in a fixed-length frame composed of a plurality of time slots and transmitted. In this case, as shown in Fig. 2, each logical channel usually corresponds to one or a plurality of time slots. In an example shown in Fig. 2, time slots #1-#3 for logical channels #a-#c are provided for each frame. In this case, for example, data to be stored in the time slot #1 are transmitted via the logical channel #a. The length of each time slot is fixed in advance.

If a frame as shown in Fig. 2 is used, the distribution device 102 stores picture data taken by the camera 101a in the time slot #2 and stores picture data taken by the camera 101b in the time slots #1 and

#3. Each of the receiving devices 103a-103c extracts picture data from the time slots #1-#3, respectively. In this way, pictures taken by camera 101a are displayed on the picture monitor 104b, and pictures taken by camera 101b are displayed on the picture monitors 104a and 104c.

In the system described above, each receiving device is connected to a predetermined logical channel. In the example shown in Fig. 1, the logical channels #a-#c are fixedly connected to the receiving devices 103 a-103c, respectively. Specifically, the receiving devices 103a-103c can receive only picture data transmitted via the logical channels #a-#c, respectively.

Therefore, in order to display the same picture on a plurality of picture monitors, the same picture data must be transmitted via the number of logical channels equal to the number of the picture monitors. In this case, a plurality of logical channels are used by a plurality of picture data that is the same. In the example shown in Fig. 1, the two logical channels #a and #c are occupied by picture data outputted from the camera 101b. As a result, the efficiency of use of communications resources (the band of a transmission line 105) is degraded.

If the display of a picture monitor is switched, sometimes the display of another picture monitor may also be simultaneously switched.

Furthermore, in a configuration such that logical
5 channels are connected to receiving devices on a one to one basis, the number of picture monitors which can be connected to this system is restricted by the number of logical channels established on the transmission line 105.

10 As described above, if the existing picture distribution system adopts time division multiplexing, the efficiency of use of communications resources is low and the number of picture monitors used to display pictures is restricted.

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Summary of the Invention

An object of the present invention is to provide a picture distribution system for displaying more pictures with the high efficiency of use of
20 communication resources.

The picture distribution system of the present invention has a configuration such that picture data are distributed from a distribution device to a plurality of receiving devices, and comprises a
25 network in which a plurality of logical channels are

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allocation unit and transmitting the distribution instruction to the distribution device.

In the configuration described above, if there is a small number of picture data to be distributed simultaneously, a broad band can be allocated to each set of picture data, and as a result, a high-resolution picture can be displayed. On the other hand, if there is a large number of picture data to be distributed simultaneously, by allocating a narrow band to a specific set of picture data, if possible, the remaining band can be allocated to another set of picture data. In this way, according to the picture distribution system of the present invention, communications resources can be efficiently used.

Brief Descriptions of the Drawings

Fig. 1 shows the configuration of an example of the existing picture distribution system.

Fig. 2 shows a frame for storing picture data.

Fig. 3 shows the configuration of a picture distribution system in one preferred embodiment of the present invention.

Fig. 4 shows a frame used in an SDH (Synchronous Digital Hierarchy).

Fig. 5 shows how to control a distribution device

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Fig. 18 shows a block diagram of a distribution

Fig. 19 shows a block diagram of a receiving device.

Figs. 20 through 23 show the operation sequence of the picture distribution system.

Fig. 24 is a sequence chart showing the operation of a distribution device in a case where the distribution device receives a band change request.

Fig. 25 is a sequence chart showing the operation of the receiving device.

Figs. 26 and 27 show examples of how to store picture data in an SDH frame.

15 The preferred embodiments of the present invention are described below with reference to the drawings.

Fig. 3 shows the configuration of a picture distribution system in one preferred embodiment of the present invention. The reference numerals and symbols used both in Fig. 1 and Fig. 3 represent the same devices. Specifically, the existing cameras 101a-101c, picture monitors 104a-104c and transmission line 105 can be used without modification. Picture data are transmitted from a distribution device 1 to

receiving devices 5a-5b via a transmission line 105 by a time division multiplex method. In the following description, it is assumed that an SDH multiplex method is adopted in data transmission via the transmission line 105. An SDH (Synchronous Digital Hierarchy) is a digital communications standard recommended by ITU-T.

The distribution device 1 transmits each piece of picture data to a corresponding logical channel. In an example shown in Fig. 3, the distribution device 1 transmits picture data outputted from the camera 101a to the logical channel #b and transmits picture data outputted from the camera 101b to the logical channel #a. The distribution device 1 never transmits a specific set of picture data to a plurality of logical channels.

The receiving devices 5a-5c can extract picture data from one arbitrary logical channel among a plurality of logical channels established in the transmission line 105. In the example shown in Fig. 3, the receiving devices 5a, 5b and 5c extract picture data from the logical channels #a, #b and #c, respectively. The picture data received by the receiving devices 5a-5c are supplied to the picture monitors 104a-104c, respectively. In this way,

pictures taken by the camera 102a are displayed on the picture monitor 104b, and pictures taken by the camera 101b are displayed on the picture monitors 104a and 104c. In this case, the logical channel #c is not used.

As described above, according to the picture distribution system of this preferred embodiment, a specific piece of picture data is never simultaneously transmitted via a plurality of logical channels.

Specifically, according to the conventional system shown in Fig. 1, two logical channels (#a and #c) are occupied in order to display a picture taken by the camera 101b on two picture monitors (104a and 104c).

However, according to the system of this preferred embodiment, the picture taken by the camera 101b can be displayed on the two picture monitors (104a and 104c) by transmitting the picture data via one logical

channel. Therefore, according to the system of this preferred embodiment, the efficiency of use of communication resources (the band of the transmission line 105) is high. In addition, since each of the

receiving devices 5a-5c can receive picture data from a desired logical channel, each receiving device can switch a logical channel to be connected without affecting the other receiving devices. Therefore,

Fig. 4 shows a frame used in an SDH. Picture
5 data are stored in this frame and transmitted.

The picture data are stored in the payload of each frame, when transmitted from a distribution device to a receiving device. The position used to store picture data outputted from a camera is recognized by the distribution device.

Fig. 5 shows how to control a distribution device and a receiving device. A distribution device 1 is controlled by a distribution instruction issued by a central device 11. The central device 11 is installed, for example, in a central station which manages this entire system, and is connected to one or more user terminals (operation terminals) via a LAN. In this case, information for designating a picture to be displayed on the picture monitors 104a-

15 The receiving devices 5a-5c are controlled by a
receiving instruction issued by the central device 11
or distribution device 1. If the central device 11
and each of the receiving devices 5a-5c are connected
by a LAN, etc., the central device 11 transmits the
20 receiving instruction to each of the receiving devices
5a-5c via the LAN, etc. A receiving instruction can
also be transmitted from the distribution device 1 to
each of the receiving devices 5a-5c via the
transmission line 105. In this case, the distribution
25 device 1 generates a receiving instruction based on

In the example shown in Fig. 5, a distribution instruction is transmitted from the central device 11 to the distribution device 1 via a dedicated line or LAN, and a receiving instruction is transmitted from the distribution device 1 to each of the receiving devices 5a-5c via the transmission line 105.

If a distribution instruction or receiving instruction is transmitted via the transmission line 105, the instruction is stored in this user channel byte. In the example shown in Fig. 5, when generating a receiving instruction, the distribution device 1 stores the instruction in the user channel byte of each frame and transmits the frame via the

Next, how picture data are transmitted via a transmission line 105 is described. As described above, the picture data are stored in the payload of the SDH frame shown in Fig. 4 and transmitted over the transmission line 105. Here, SDH frames are consecutively transmitted at specific intervals. Specifically, SDH frames are consecutively transmitted at the speed of 8,000 frames/second. The data string of this transmitted frame is often called a "transport stream".

For example, if each of three pieces of picture data is stored in the corresponding sub-area of each frame and the frames are sequentially transmitted, it can be said that the three pieces of picture data are transmitted with time division multiplexing.

As shown in Fig. 7A, each of the sub-areas described above corresponds to each of the time slots #1-#3 used to transmit each piece of the picture data

in terms of a time coordinate. In this case, if a band used to transmit picture data is assumed to be, for example, 18 MHz, each band allocated to each of the time slots #1-#3 is 6 MHz, as shown in Fig. 7B.

5 Fig. 8 shows how to control a band used to transmit picture data depending on a distribution state. Here, a case where respective pictures taken by cameras 101a-101c have been being displayed on picture monitors 104a-104c, respectively, and a
10 picture taken by a camera 101d is newly displayed on a picture monitor 104d, will be explained.

As shown in Fig. 9A, while respective pictures taken by the cameras 101a-101c are being displayed on the picture monitors 104a-104c, respectively, the
15 distribution device 1 stores the respective pictures data outputted by the cameras 101a-101c in the time slots #1-#3, respectively, and transmits the data to the transmission line 105. Here, the respective paths used to transmit data using the time slots #1-#3 are
20 defined as logical channels #a-#c, respectively. In this case, respective pieces of picture data outputted from the cameras 101a-101c are transmitted via the logical channels #a-#c, respectively. The receiving devices 5a-5c receive picture data from the logical
25 channels #a-#c, respectively.

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distribution instruction, the distribution device 1 divides the time slot #3 into two pieces and stores picture data outputted from the camera 101c and picture data outputted from the camera 101d in the former half and latter half, respectively. At this time, the distribution device 1 compresses picture data outputted from the cameras 101c and 101d into data at a rate of 3 Mbps, respectively. In this way, two logical channels #c1 and #c2 using the time slot #3 are established in the transmission line 105. The respective bands of the logical channels #1c and #c2 are 3 Mbits, respectively. The distribution device 1 notifies the receiving devices 5a-5d of the modification of the time slot assignment (receiving instruction or multiplexing information). This receiving instruction is transmitted, for example, using an SOH.

Although the receiving device 5c obtains picture data from the whole time slot #3 before receiving the receiving instruction described above, it obtains picture data only from the former half of the time slot #3 after receiving the receiving instruction. On receipt of the receiving instruction, the receiving device 5d obtains picture data from the latter half of the time slot #3.

As described above, according to the picture distribution system of this preferred embodiment, if new picture data are transmitted in a situation where all bands are already used to transmit picture data, a new logical channel is established by adjusting a band to be allocated to each piece of picture data, and the new picture data are transmitted via the newly established logical channel. In other words, although the system adopts time division multiplexing, the number of channels used to transmit picture data can be increased without increasing the total band used to transmit picture data. As a result, the band of a transmission line can be efficiently used.

Although in the preferred embodiment described above, picture data outputted from each camera are distributed to receiving devices by one distribution device, generally speaking, many picture distribution system are provided with a plurality of distribution devices. Fig. 10 shows an example of a picture distribution system with a plurality of distribution devices. In this example, a distribution device 1 accommodates cameras 101a-101c and a distribution device 2 accommodates a camera 101d.

In the system shown in Fig. 10, pictures taken by the cameras 101a-101c are assumed to be displayed

5 In this situation, it is assumed that a request
to "display a picture taken by a camera 101d on a
monitor 104d" is inputted from a user terminal. In
this case, the central device 11 checks whether there
is an unused time slot, recognizes a distribution
10 device which accommodates the camera 101d, and
generates a distribution instruction based on those
results. Then, the central device 11 notifies both
the distribution devices 1 and 2 of the distribution
instruction.

15 On receipt of this distribution instruction, the
distribution device 1 stores picture data outputted
by the cameras 101a and 101b in the time slots #1 and
#2, respectively, and stores picture data outputted
from the camera 101c in the former half of the time
20 slot #3. In this case, the distribution device 1
stores, for example, dummy data in the latter half of
the time slot #3. On receipt of the distribution
instruction, the distribution device 2 stores picture
data outputted from the camera 101d in the latter half
25 of the time slot #3. In this way, the picture data

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distribution device installed in the picture distribution system. Specifically, the distribution state table defines the correspondence between each time slot used to transmit picture data and picture data to be stored in the time slot. A "time slot number" is information for identifying a time slot to store picture data. The number can also be indicated using a position in the payload of the frame shown in Fig. 4. "How to store picture data" indicates a size of picture data to be stored in each time slot and a position where the picture data are stored. In the example shown in Fig. 11, for example, picture data taken by the camera 101c are stored in the former half of the time slot #3 by the distribution device 1, and picture data taken by the camera 101d are stored in the latter half of the time slot #3 by the distribution device 2. A distribution device can generate information for instructing how to place picture data on a transport stream based on the content of this table. This information is sometimes transmitted to receiving devices as multiplexing information (transport stream multiplexing information).

Fig. 12 shows a receiving state table. The receiving state table manages the state of each

receiving device. Specifically, the receiving state table defines the source of picture data which each receiving device receives (a transmitting device: in this preferred embodiment, both a distribution and a camera). The example shown in Fig. 12 shows that a receiving device 5a is receiving picture data which are outputted from a camera 101a and are transmitted by the distribution device 1.

Figs. 13A and 13B show a priority table. The priority table shown in Fig. 13A defines the priority of each receiving device, and the priority table shown in Fig. 13B defines the priority for each camera.

On receipt of a request related to a picture display from a user terminal, the central device 11 refers to a variety of tables, as shown in Figs. 11, 12, 13A and 13B, generates an instruction to be transmitted to the distribution device and also generates an instruction to be transmitted to the receiving device, if required. Then, the central device 11 transmits the generated instruction to the distribution device (and also to the receiving device, if required).

The following requests are considered to be transmitted from a user terminal to the central device 11.

(a) A request to display a picture on a specific picture monitor.

(b) A request to stop the picture display of a specific picture monitor.

5 (c) A request to switch a picture on a specific picture monitor to another picture.

Fig. 14 is a flowchart showing the operation of a central device which receives request (a) described above. Here, it is assumed that the request from the
10 user terminal includes at least information for identifying a camera and information for identifying a picture monitor used to display pictures taken by the camera.

In step S1, it is checked whether picture data
15 from a requested camera are currently distributed. In this judgment, a distribution state table is referenced. If picture data from the requested camera are being distributed, a distribution instruction is not generated, but in step S2, a receiving instruction
20 is generated and the receiving instruction is transmitted in step S3.

If picture data from the requested camera are not being distributed, in step S11, it is checked whether there is an unused time slot. In this judgment, a
25 distribution state table is referenced. If there is

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an unused time slot, in step S12, picture data taken by the requested camera are assigned to the unused time slot. Then, in steps 13 and S2, a distribution instruction and a receiving instruction are generated, respectively, and those instructions are transmitted in step S3.

If there is no unused time slot, in step S21, a time slot with low priority is selected from among used time slots. In this selection, the priority tables shown in Figs. 13A and 13B are referenced. Then, in step S22, the time slot selected in step S21 is divided. Then, in step S23, a picture previously assigned to the selected time slot is assigned to the former half of the selected time slot and a picture taken by the requested camera is assigned to the latter half of the selected time slot. Then, steps S13, S2 and S3 are executed.

A specific example of the operation of the flowchart shown in Fig. 14 is described below. In the following description, as shown in Fig. 10, it is assumed that a distribution device 1 accommodates cameras 101a-101c and a distribution device 2 accommodates a camera 104d. It is also assumed that receiving devices 5a-5d are connected to picture monitors 104a-104d, respectively. It is also assumed

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central device 11 issues a distribution instruction to "store picture data outputted from the camera 101c in the time slot #3" to the distribution device 1 which accommodates the camera 101c.

15 Example 3: A request to "display the picture of
a camera 101d on a picture monitor 104d" is issued
in a state where pictures taken by cameras 101a
through 101c are being displayed on picture monitors
104a through 104c, respectively.

25 In the case of example 3, the judgment in step
S1 is "No" as in the case of example 2, and step S11

is executed. In step S11, the distribution state table is referenced. At this time, the distribution state table is in the state shown in Fig. 15B, and all the time slots are already used. Therefore, steps S21 through S23 are executed.

In step S21, a time slot with low priority is selected. If the priority table shown in 13A is referenced, it is found that the priority of a receiving device 5c is the lowest of receiving devices 5a-5c. Therefore, a time slot #3 corresponding to the receiving device 5c is selected. If the priority table shown in Fig. 13B is referenced, it is found that the priority of a camera 101c is the lowest of cameras 101a-101c. Therefore, the time slot #3 corresponding to the camera 101c is selected. The time slot selected when the priority table shown in Fig. 13A is referenced and the time slot selected when the priority table shown in Fig. 13B is referenced do not always match.

Then, in steps S22 and S23, a picture taken by a camera 101c and a picture taken by a camera 101d are assigned to the former half and latter half, respectively, of a time slot #3. As a result, the distribution state table is updated from the state shown in Fig. 15B to the state shown in Fig. 15C.

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On receipt of the request, the central device 11 performs a process of the flowchart shown in Fig. 17. In this example, on the picture monitor 104c, a picture taken by the camera 101a is displayed. Here, the picture taken by the camera 101a is displayed also

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Therefore, judgment in step S31 is "No", and step S41 is executed. At this time, the picture taken by the camera 101c is assigned to a time slot #3, and the time slot #3 is used without being divided.

5 Therefore, in step S42, the time slot #3 is released. As a result, the distribution state table is updated from the state shown in Fig. 15B to the state shown in Fig. 15A. The central device 11 issues a distribution instruction "not to distribute picture
10 data outputted from the camera 101c" to a distribution device 1 which accommodates the camera 101c.

The central device further issues a receiving instruction to "stop the reception of picture data" to a receiving device 5c to which the picture monitor
15 104c is connected. At this time, the receiving state table is updated from the state shown in Fig. 16C to the state shown in Fig. 16A. Then, on receipt of this receiving instruction, the receiving device 5c stops the operation of receiving picture data from a
20 transmission line 105. In this way, the picture display of the picture monitor 104c is stopped.

Example 3: A request to "stop the display of a picture monitor 104d" is issued in a state where pictures taken by cameras 101a-101d are being
25 displayed on picture monitors 104a-104d, respectively.

5 In the case of example 3, the judgment in step
S31 is "No" and step S41 is executed as in the case
of example 2. At this time, a picture taken by the
camera 101d is assigned to a time slot #3, and the
time slot #3 is divided to establish two channels.
10 Specifically, the picture of the camera 101c and the
picture of the camera 101d are assigned to the former
half and latter half of the time slot #3,
respectively. Therefore, in step S51, the time slot
#3 is once released and then the picture of the camera
15 101c is assigned to the whole time slot #3. As a
result, the distribution state table is updated from
the state shown in Fig. 15C to the state shown in Fig.
15B. Then, the central device 11 issues a
distribution instruction to "store picture data
20 outputted from the camera 101c in the time slot #3"
to the distribution device 1 which accommodates the
camera 101c and a distribution instruction "not to
distribute picture data outputted from the camera
101d" to the distribution device 2 which accommodates
25 the camera 101d, respectively.

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The central device 1 further issues a receiving instruction to "receive the picture data of the time slot #3" to the receiving device 5c to which the picture monitor 104c is connected and a receiving instruction to "stop the reception of picture data" to the receiving device 5d to which the picture monitor 104d is connected. At this time, the receiving state table is updated from the state shown in Fig. 16D to the state shown in Fig. 16C. Then, the receiving device 5c receives the picture data from the whole time slot #3, and the receiving device 5d stops the operation of receiving the picture data. In this way, the picture display of the picture monitor 104d is stopped.

The switching from a picture displayed on a specific picture monitor to another picture can be achieved, for example, by combining the processes indicated by the flowcharts shown in Figs. 14 and 17.

Fig. 18 shows a block diagram of a distribution device. The distribution device multiplexes picture data outputted from a camera on the transmission line 105 according to an instruction from the central device 11.

A line interface unit 21 interfaces a network (transmission line 105). Specifically, the line

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5 multiplexing unit 23 outputs picture data from the demultiplexing unit 22. In this case, the distribution device passes the picture data transmitted from the upstream to the downstream side without modification. If an "ON instruction" is issued from the control unit 31, the multiplexing unit 23 outputs the picture data read from the buffer memory 30. In this case, the distribution device multiplexes the picture data transmitted from the upper side with picture data from a camera accommodated in this distribution device. The multiplexing unit 23 attaches multiplexing information to a frame which stores the picture data. As described earlier, this multiplexing information indicates how to place picture data on a transport stream.

20 The control unit 31 controls the operation of this distribution device according to an instruction (distribution instruction) from the central device 11. Specifically, the control unit 31 designates a video input for the selector 25 to select. The control unit 31 also designates a sampling speed and a number of conversion bits of the A/D converter 26. The control unit 31 also designates the compression rate, etc., of the encoding unit 29. The control unit 31 also

generates the ON signal and the OFF signal used to multiplex picture data for the multiplexing unit 23. The control unit 31 also controls a camera accommodated in the distribution device. In this case, for example, an RS-232C interface is used.

In the distribution device with the configuration described above, when receiving a distribution instruction to multiplex a video input 1 in the time slot #1, the control unit 31 gives the following instructions to the selector 25, encoding unit 29 and multiplexing unit 23.

To selector 25: An instruction to select a video input 1.

To encoding unit 29: Compression rate used to compress picture data into 6 Mbps.

To multiplexing unit 23: ON instruction (a period corresponding to the time slot #1).

If a video input 3 is multiplexed with the former half of the time slot #3, the control unit 31 generates the following instructions.

To selector 25: An instruction to select a video input 3.

To encoding unit 29: Compression rate used to compress picture data into 3 Mbps.

To multiplexing unit 23: ON instruction (a period

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demultiplexing unit 44 also extracts multiplexing information attached by the distribution device from the received frame, if such information is required, and supplies the control unit 50 with the information.

5 A decoding unit 45 decodes encoded picture data.
The decoding method is determined by an encoding
method used when the picture data is encoded. A
memory 46 temporarily stores the picture data decoded
by the decoding unit 45. A D/A converter 47 converts
10 the digital picture data decoded by the decoding unit
45 to analog picture data and supplies a picture
monitor with the converted picture data. While
synchronization is detected by the synchronization
detection unit 43, the picture data decoded by the
15 decoding unit 45 is supplied to the picture monitor.
However, if abnormal synchronization is detected, past
picture data stored in the memory 46 are supplied to
the picture monitor according to a freeze instruction
issued by the synchronization detection unit 43.

20 A clock regeneration unit 48 regenerates a clock
signal based on the clock information of the
distribution device which can be obtained from the
data demultiplexing unit 44, and synchronizes the
clock signal of the distribution device with the clock
25 signal of this receiving device. A selector 49

selects either a clock signal generated by the PLL unit 42 or a clock signal generated by the clock regeneration unit 48, and outputs the signal as an internal clock signal.

5 The control unit 50 controls the operation of this receiving device according to an instruction from the central device 11 or a distribution device. Specifically, the control unit 50 designates a position (or timing) in which picture data to be
10 extracted are stored for the data demultiplexing unit 44. The control unit 50 also issues the freeze instruction to the decoding unit 45 and memory 46.

 Figs. 20 through 23 show the operation sequence of the picture distribution system. In this preferred
15 embodiment, it is assumed that distribution devices 1 and 2 accommodate a camera 3 (camera 101c) and a camera 4 (camera 101d), respectively. A case where the display of a picture monitor K is switched from the picture of the camera 3 to the picture of the
20 camera 4 in a state where the picture of the camera 3 is being displayed on the picture monitor K connected to a receiving device K is also assumed.

 A user issues a request to "switch the display of the picture monitor K from the picture of a camera
25 3 to the picture of a camera 4" using a user terminal.

On receipt of this request, the central device 11 first refers to a receiving state table and checks whether the picture of the camera 3 is displayed on a picture monitor other than the picture monitor K.

5 If the picture of the camera 3 is not displayed on another picture monitor, the central device 11 issues a distribution stop request to the distribution device 1 to stop the distribution of the picture of the camera 3. This distribution stop request contains
10 allocation information. The allocation information includes information for identifying a logical channel (time slot used to store picture data) used to transmit picture data and information about how to place picture data on a transport stream (information
15 indicating a position used to store the picture data).

On receipt of this request, the distribution device 1 issues an output stop request to the camera 3. The camera 3 stops the output of picture data in response to the request and returns an output stop
20 reply to the distribution device 1. On receipt of the reply from the camera 3, the distribution device 1 stops the distribution of picture data designated by the distribution stop request from the central device 11. Specifically, the distribution device 1 stops the
25 transmission of picture data from the camera 3 using

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a logical channel designated according to the assignment information. Then, the distribution device 1 issues a distribution stop reply to the central device 11.

5 On receipt of the reply from the distribution device 1, the central device 11 updates a distribution state table. Specifically, a record corresponding to the camera 3 is deleted from the distribution state table.

10 If the picture of the camera 3 is displayed on a picture monitor other than the picture monitor K when the request from a user terminal is received, it is checked whether there is an unused band for logical channels used to transmit the picture data. If there
15 is an unused band, the flow proceeds to a process shown in Fig. 21. If there is no unused band, the flow proceeds to a process shown in Fig. 22.

Next, the process shown in Fig. 21 is described. After stopping the distribution of the picture of the
20 camera 3, the central device 11 refers to the distribution state table and checks whether the picture of a camera 4 is currently distributed. If the picture of the camera 4 is not being distributed, the central device 11 issues a distribution request
25 to the distribution device 2 to distribute the picture

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of the camera 4. This distribution request also contains allocation information.

5 The distribution device 2 makes a request for the camera 4 to output picture data based on the received distribution request. The camera 4 outputs the picture data and returns an output reply to the distribution device 2. On receipt of this reply, the distribution device 2 starts the distribution of the picture data outputted from the camera 4 and returns
10 a distribution reply to the central device 11. At this time, the distribution device 2 transmits the picture data from the camera 4 via a logical channel (time slot) designated by the distribution request from the central device 11.

15 On receipt of the distribution reply from the distribution device 2, the central device 11 updates a distribution state table. Specifically, the central device 11 adds a record corresponding to the camera 4. If a picture of the camera 4 is being distributed
20 when a request to display the picture is received from the user terminal, the central device 11 does not issue a distribution request to distribute the picture of the camera 4.

25 Then, the central device 11 issues a receiving request to the receiving device K to which the picture

monitor K used to display the picture of the camera
4 is connected. This receiving request contains
allocation information. This allocation information
is basically the same as the allocation information
5 contained in the distribution request transmitted to
the distribution device 2. On receipt of the
receiving request, the receiving device K switches a
logical channel (time slot) used to receive the
picture data according to the allocation information.
10 In this example, since the allocation information
contained in the distribution request, which is
transmitted to the distribution device 2, and the
allocation information contained in the receiving
request, which the receiving device K receives, are
15 basically the same, the receiving device K can receive
picture data, which the distribution device 2
distributes according to the distribution request.

Then, the receiving device K returns a receiving
reply to the central device 11. On receipt of the
20 reply, the central device 11 updates a receiving state
table. Specifically, the central device 11 updates
the distribution device number and camera number of
a record corresponding to the receiving device K.

In the sequence described above, the display of
25 the receiving monitor K is switched from the picture

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of the camera 3 to the picture of the camera 4.

If all bands for transmitting picture data are already in use when the distribution of the picture of the camera 4 is requested from the user terminal, the flow proceeds to the sequence shown in Fig. 22. In this case, the central device 11 first refers to the receiving state table and a priority table, and searches for a picture which is being received only by a receiving device with low priority. This is because a part of a band used to transmit a picture which is displayed on a receiving terminal with low priority is assigned to the picture of the camera 4. If the central device 11 detects such a picture, it issues a band change request to a distribution device which is currently distributing the picture. If the central device 11 cannot detect such a picture, it issues a message to the user terminal indicating that the user's request is not accepted. If a plurality of pictures which are being received only by receiving devices with low priority are detected, an arbitrary picture is selected at random from the pictures.

It is assumed that the central device 11 has issued a band change request to a distribution device 1. This band change request contains allocation information. In this case, the allocation information

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includes "information indicating that the band of the picture data from the camera 3 is compressed and information about the storage position of the compressed picture data".

5 On receipt of the band change request, the distribution device 1 compresses the picture data from the camera 3 according to the assignment information, stores the compressed picture data in a designated position and distributes the data. Then, the
10 distribution device 1 returns a band change reply to the central device 11. If the camera 3 is provided with a function to modify the band of picture data, the band change request is transferred to the camera 3, and the camera 3 compresses the picture data
15 according to the request. In this case, the distribution device 1 simply stores picture data received from the camera 3 in the designated position without processing and outputs the data.

20 On receipt of the band change reply from the distribution device 1, the central device 11 updates a distribution state table. Specifically, the central device 11 updates information about how to store picture data of a record corresponding to the camera 3.

25 Next, Fig. 23 is described. The sequence shown

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in Fig. 23 is basically the same as that shown in Fig. 21. However, in the sequence shown in Fig. 23, a distribution request issued from the central device 11 to a distribution device 2 contains an instruction to compress picture data from a camera 4. Therefore, on receipt of this distribution request, the distribution device 2 compress the picture data from the camera 4, stores the compressed picture data in a position designated by the distribution request and distributes the data.

As described above, according to the system of this preferred embodiment, even if all bands for transmitting picture data are being in use when a specific picture (in this preferred embodiment, the picture of a camera 4) is requested to be distributed, since a part of the band which has been allocated to a picture with low priority (in this preferred embodiment, the picture of a camera 3) is reallocated to the picture of the camera 4, the pictures of both cameras 3 and 4 can be distributed concurrently.

Fig. 24 is a sequence chart showing the operation of a distribution device in the case where the distribution device receives a band change request. In this example, it is assumed that a band change request issued from the central device 11 to a

Fig. 25 is a sequence chart showing the operation of a receiving device which has received a receiving request. On receipt of a receiving request from the central device 11, the control unit 50 of a receiving device issues a data demultiplex instruction to a data demultiplexing unit 44. This data demultiplex instruction designates a position (or a timing) in which picture data to be extracted are stored. Then, the data demultiplexing unit 44 extracts the designated picture data from the input frame according to this designation.

Figs. 26 and 27 show examples of how to store picture data in an SDH frame. In this example, an STM-1 frame is used.

An STM-1 frame is generated by adding an SOH to an AU-4 (management unit 4). An AU-4 is generated by adding an AU pointer to a VC-4 (virtual container 4). A VC-4 is generated by adding POH (path overhead), etc., to three TUG-3 units (tributary unit group 3). A TUG-3 is generated by adding an NPI, etc., to seven TUG-2 units. A TUG-2 is composed of eleven TU-11 units. A TU-11 is generated by adding a pointer to a VC-11 (virtual container 11). A VC-11 is generated by adding a POH to a C-11 (container 11). A C-11 is generally called a minimum container and is stores a

In the example shown in Fig. 26, each minimum container is divided into two pieces. In this case, each minimum container can store two sets of picture data outputted from two different cameras. In the example shown in Fig. 27, each minimum container stores only one set of picture data, and each TUG-2 is composed of four sets of picture data.

Although in the preferred embodiments described above, a transmission line which connects each distribution device with each receiving device is in a ring shape, the transmission line of the picture distribution system of the present invention is not necessarily limited to a ring shape. However, if a transmission line is in a ring shape, there are a variety of advantages. For example, if a transmission line for transmitting picture data is composed of a double ring and it is configured in such a way that the same picture data are transmitted in two different directions using the double ring, the picture data can be continuously distributed by looping back the signal, even if there is a failure in the transmission line (including a case where two transmission lines are simultaneously disconnected). The advantages obtained by forming a transmission line in a ring

shape are described in Japanese Patent Application No. 11-010747. However, a transmission line does not have to be in a physical ring shape. For example, even if a transmission line is a network connected in a mesh, it is acceptable if the line is theoretically organized in a ring shape.

A technology for establishing a plurality of logical channels in a network and adjusting a band to be allocated to each logical channel depending on a communications condition has been known. For example, in an ATM network, the band of a virtual path or virtual channel is often adjusted according to the traffic congestion of an exchange. However, in a system adopting time division multiplexing, a method of adjusting the band of each of the multiplexed channels depending on the number of pictures to be transmitted is not known.

In the monitoring system of the preferred embodiment described above (a system for monitoring a traffic amount of a road, a natural disaster, etc.), volume of picture data outputted from each camera is generally considered to fluctuate little. For this reason, in this type of system, a time division multiplex method has been conventionally used, and it is common that picture data outputted from each camera

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resources can be efficiently used even if the number of pictures to be displayed fluctuates.

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